

What is claimed is

Sub B 1. A method of preparing a plurality of cross-linked solution polymer particles comprising the steps of: a) providing a monomer feed comprising one or more monomers, and one or more cross-linking agents; b) providing a polymerization initiator feed comprising a polymerization initiator; c) providing a reaction vessel containing one or more reaction solvents; d) heating the one or more reaction solvents to a temperature sufficient to activate the polymerization initiator; and e) adding the initiator feed and the monomer feed to the reaction vessel at a rate such that the concentration of the one or more monomers in the one or more reaction solvents is substantially constant.

2. The method of claim 1 wherein the monomer feed and the polymerization initiator feed are combined prior to being added to the reaction vessel.

3. The method of claim 1 wherein the polymerization initiator feed further comprises one or more solvents.

4. The method of claim 1 wherein the polymerization initiator is a free radical initiator.

Sub A1 5. The method of claim 4 wherein the free radical initiator is selected from peroxyesters, dialkylperoxides, alkylhydroperoxides, persulfates, azoinitiators or redox initiators.

6. The method of claim 1 wherein at least one monomer is selected from meth)acrylic acid, (meth)acrylamides, alkyl (meth)acrylates, alkenyl (meth)acrylates, aromatic (meth)acrylates, vinyl aromatic monomers, nitrogen-containing compounds, thio-analogs of nitrogen containing compounds or substituted ethylene monomers.

7. The method of claim 1 wherein cross-linked polymer particles have a mean particle size of 0.75 to 100 nm.

8. The method of claim 1 wherein at least one monomer is selected from silyl containing monomers or poly(alkylene oxide) monomers.

9. The method of claim 1 wherein the one or more cross-linking agents is selected from trivinylbenzene, divinyltoluene, divinylpyridine, divinyl naphthalene and divinylxylene; and such as ethyleneglycol diacrylate, trimethylolpropane triacrylate, diethyleneglycol divinyl ether, trivinylcyclohexane, allyl methacrylate, ethyleneglycol dimethacrylate, diethyleneglycol dimethacrylate, propyleneglycol dimethacrylate, propyleneglycol diacrylate, trimethylolpropane

trimethacrylate, divinyl benzene, glycidyl methacrylate, 2,2-dimethylpropane 1,3 diacrylate, 1,3-butylene glycol diacrylate, 1,3-butylene glycol dimethacrylate, 1,4-butanediol diacrylate, diethylene glycol diacrylate, diethylene glycol dimethacrylate, 1,6-hexanediol diacrylate, 1,6-hexanediol dimethacrylate, tripropylene glycol diacrylate, triethylene glycol dimethacrylate, tetraethylene glycol diacrylate, polyethylene glycol 200 diacrylate, tetraethylene glycol dimethacrylate, polyethylene glycol dimethacrylate, ethoxylated bisphenol A diacrylate, ethoxylated bisphenol A dimethacrylate, polyethylene glycol 600 dimethacrylate, poly(butanediol) diacrylate, pentaerythritol triacrylate, trimethylolpropane triethoxy triacrylate, glyceryl propoxy triacrylate, pentaerythritol tetraacrylate, pentaerythritol tetramethacrylate, dipentaerythritol monohydroxypentaacrylate, divinyl silane, trivinyl silane, dimethyl divinyl silane, divinyl methyl silane, methyl trivinyl silane, diphenyl divinyl silane, divinyl phenyl silane, trivinyl phenyl silane, divinyl methyl phenyl silane, tetravinyl silane, dimethyl vinyl disiloxane, poly(methyl vinyl siloxane), poly(vinyl hydro siloxane), or poly (phenyl vinyl siloxane).

10. A plurality of cross-linked solution polymer particles having a mean particle size of ≤ 30 nm and a particle size polydispersity of from 1 to 15.

11. The plurality of cross-linked polymer particles of claim 10 wherein the particle size polydispersity is from 1 to 10.

12. The plurality of cross-linked polymer particles of claim 11 wherein the particle size polydispersity is from 1 to 7.

13. The plurality of cross-linked polymer particles of claim 10 wherein the particles have a mean particle size of ≤ 20 nm.

14. A plurality of cross-linked solution polymer particles having a mean particle size of ≤ 10 nm, wherein the plurality of polymer particles is substantially free of polymer particles having a particle size of 30 nm or greater.

15. The plurality of cross-linked polymer particles of claim 14 wherein the particles have a mean particle size of ≤ 5 nm.

16. The plurality of cross-linked polymer particles of claim 14 wherein the plurality of polymer particles is substantially free of polymer particles having a particle size of 20 nm or greater.

Sub A2 17. A composition comprising one or more B-staged dielectric materials and a plurality of cross-linked solution polymers having a mean particle size of ≤ 30 nm and a particle size polydispersity in the range of 1 to 15.

Sub B 18. The composition of claim 17 wherein the particle size polydispersity is from 1 to 10.

19. The composition of claim 17 wherein the particle size polydispersity is from 1 to 7.

Sub A3 20. The composition of claim 17 wherein the particles have a mean particle size of ≤ 20 nm.

21. A composition comprising one or more B-staged dielectric materials and a plurality of cross-linked solution polymers having a mean particle size of ≤ 10 nm, wherein the plurality of polymer particles is substantially free of polymer particles having a particle size of 30 nm or greater.

22. The composition of claim 21 wherein the particles have a mean particle size of ≤ 5 nm.

Sub B 23. The composition of claim 21 wherein the plurality of polymer particles is substantially free of polymer particles having a particle size of 20 nm or greater.

24. A porous dielectric matrix material comprising a plurality of pores having a mean diameter of ≤ 5 nm.

Sub A4 25. The porous dielectric matrix material of claim 24 wherein the plurality of pores have a mean diameter of ≤ 3 nm.

26. The porous dielectric matrix material of claim 24 wherein the plurality of pores have a mean diameter of ≤ 2 nm.

27. The porous dielectric matrix material of claim 24 wherein the plurality of pores have a mean diameter in the range of 0.75 to 3 nm.

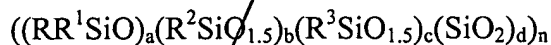
Sub B 28. An electronic device comprising one or more layers of porous dielectric matrix material comprising a plurality of pores having a mean diameter of ≤ 5 nm.

29. The electronic device of claim 25 wherein the plurality of pores has a mean diameter of ≤ 2 nm.

Sub A5 30. The electronic device of claim 25 wherein the plurality of pores have a mean diameter in the range of 0.75 to 3 nm.

Sub B' 31. A method of manufacturing an electronic device comprising the steps of: a) depositing on a substrate a layer of a composition comprising B-staged dielectric material having a plurality of cross-linked solution polymeric porogens dispersed therein, wherein the polymeric porogens have a mean particle size of ≤ 5 nm; b) curing the B-staged dielectric material to form a dielectric matrix material without substantially removing the porogen; c) subjecting the dielectric matrix material to conditions which at least partially remove the porogen to form a porous dielectric material layer without substantially degrading the dielectric material; d) patterning the dielectric layer; e) depositing a metallic film onto the patterned dielectric layer; and f) planarizing the film to form an electronic device.

32. The method of claim 31 wherein the B-staged dielectric material is an organo polysilica compound having the formula:



wherein R, R¹, R² and R³ are independently selected from hydrogen, (C₁-C₆)alkyl, aryl, and substituted aryl; a, c and d are independently a number from 0 to 1; b is a number from 0.2 to 1; n is integer from about 3 to about 10,000; provided that a + b + c + d = 1; and provided that at least one of R, R¹ and R² is not hydrogen.

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